INDOOR AIR QUALITY ASSESSMENT

Greenfield Middle School
195 Federal Street
Greenfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
July, 2002

Background/Introduction

At the request of Margarette Simon, Interim Business Manager, Greenfield School Department (GSD), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) was asked to provide assistance and consultation regarding conditions within the Greenfield Middle School (GMS), 195 Federal Street, Greenfield, Massachusetts. The GMS was reopened in September, 2001 after an extensive renovation of the building interior and the construction of a gymnasium and wing on the rear of the building.

On January 24, 2002, a visit was made to this school by Michael Feeney, Director of Emergency Response/Indoor Air Quality Program (ER/IAQ), BEHA, to conduct an indoor air quality assessment. Mr. Feeney was accompanied by various GSD personnel including, Burt White, GSD Facilities Manager and Ms. Simon. Mr. Feeney returned to the building on May 16, 2002 to examine the roof and various components of the ventilation system while the building was operating in air-conditioing mode in warm weather. In addition, observations were made in the building after several substantial rainstorms to observe the performance of the roof and window systems. Since New England experienced a drought during the winter, examining these components for water penetration was not practical. Mr. Feeney was accompanied by Lisa Hebert, of the Greenfield Board of Health, Mr. White and GSD maintenance staff.

BEHA staff previously assessed the GMS during the renovation (MDPH, 2000). The GMS is a two-story brick building with an occupied basement. Building structures and components that were either constructed or renovated include:

1. Removal of the original ventilation system;
2. Installation of a new ventilation system with air conditioning;

3. Replacement of the roof;
4. Replacement of windows with energy efficient models;
5. Installation of floor tile over the original floor;
6. Addition of a gymnasium;
7. Addition of a wing to the rear of the building;
8. Installation of a new boiler system;
9. Renovation of the kitchen/cafeteria;
10. Installation of a wood dust collector for the wood shop;
11. Installation of a pottery kiln; and
12. Installation of a suspended ceiling system.

The building was turned over to the GSD several weeks prior to the May, 2002 visit. The building was fully occupied at the time of this indoor air quality assessment.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The school has a student population of approximately 900 and a staff of approximately 120. Tests were taken during normal operations at the school and results appear in Tables 1-5.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in twenty-seven out of forty five areas surveyed, indicating a ventilation problem in the school. Particular areas of note are rooms 101, 116 and 144, which had carbon dioxide levels of over 2,000 ppm, indicating a lack of air exchange.

A heating, ventilation and air conditioning (HVAC) system provides ventilation. Fresh air is provided by a number of different rooftop-mounted air handling units (AHUs) (see Pictures 1 through 4). These AHUs are connected to ducts that supply fresh air to rooms through wall mounted and ceiling mounted air diffusers (see Picture 5). The exhaust ventilation system consists of wall or ceiling mounted exhaust grilles that connect to the rooftop AHUs. Each AHU has a means to draw fresh air and expel exhaust air. The HVAC system appeared to be deactivated in a number of areas within the building during the air testing of January 24, 2002.

In order to have proper ventilation with a mechanical supply and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. According to school department officials, the date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please consult Appendix I of this assessment.

Temperature readings ranged from 67^{o} F to 76^{o} F, which were below BEHA comfort guidelines in some areas. The BEHA recommends that indoor air temperatures be maintained in a range between 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. In addition, it is difficult to control temperature and maintain comfort without operating the ventilation equipment as designed. While temperature is generally not a health concern, temperatures outside the recommended range would produce more comfort based complaints from building occupants.

The relative humidity in the building ranged from thirty-two to forty-two percent, which was below the recommended comfort range in some areas. The BEHA recommends that indoor air relative humidity is comfortable in a range of forty to sixty percent. The sensation of dryness and irritation is common in a low relative humidity environment. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Humidity is more difficult to control during the winter heating season. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

GMS maintenance staff reported that the building experiences water leaks in several areas, presumably from the roof. BEHA staff conducted a detailed examination of the roof over the new wing and gymnasium. The roof was joined to the original exterior wall in the following manner. It appeared that a ~1 ½ inch slit was cut into the exterior brick. Flashing was inserted into the slit and is held in position by a heavy coat of sealing compound. The installation of flashing is usually installed in a manner to insert the flashing and a lip behind the exterior wall to direct water onto the roof. All horizontal sections of the new roof are held into position in this manner. A number of areas of *vertical* sections of roof joined to the original exterior wall are missing sealant or flashing to hold the membrane to the brick (see Pictures 6 and 7). It is usual practice to have the joints of the roof membrane/exterior wall to be continuous to prevent water penetration. Each of these various sections of the roof may be prone to water penetration and need to be sealed.

Other defects were noted in the roof. A space the width of Mr. Feeney's hand was found between the exterior wall and ventilation system duct (see Picture 8) for an AHU located on the lower roof. According to Mr. White, this space corresponds to a leak noted below the unit that occurred during a rainstorm with an east wind. A copper roof was installed above a section of the gymnasium. Sections of vertical copper sheets were affixed to other sections of the roof using rivets (see Picture 9). A number of these rivets have failed, allowing for the vertical sections to fan away from the wall (see Picture 10). Under wind driven rain, water may get behind these sections to penetrate through the copper roof.

The gymnasium exterior walls and atrium have several potential water penetration problems. A corner of the gymnasium allows for rainwater to freely moisten the exterior wall system, as demonstrated by the green discoloration of the brick from runoff from the copper roof (see Picture 11). Chronic moistening of the brickwork in this manner may lead to erosion and possible water penetration.

A glass/steel awning roof was installed along the southeast corner of the building. These cantilever roofs are installed through the exterior brickwork. Large spaces exist around the roof supports, which can serve as a pathway for wind-driven rainwater to penetrate into the building. A downspout exists at the corner of the atrium that terminates several feet above the sidewalk (see Picture 12). The height of the terminus of the downspout will tend to create splashing water, which would expose the window system to chronic wetting.

The highest point of the building is the auditorium, which is covered by a peaked roof. The peaked roof directs rainwater into areas that were formerly courtyards. The renovation of the building filled in the courtyard with the lower roof and HVAC equipment. The HVAC equipment and ductwork in the woodshop courtyard will be chronically exposed to rainwater and possibly falling ice and snow due to its proximity below the auditorium's roof edge (see Picture 13). In order to prevent water penetration into and premature degradation of both HVAC equipment and ductwork, it is strongly recommended that a gutter/downspout system be installed to direct rainwater from this equipment. In addition, installation of some device that breaks up ice and snow should be installed to decrease the chance of damage to rooftop HVAC equipment below this roof.

Other Concerns

As previously noted, the GMS was subject to bird infestation during the renovation of the building (MDPH, 2000). Recommendations were made concerning remediation of bird waste in the building. Of particular concern was newly installed ventilation system ductwork. New ducting was stored inside the GMS during renovation, resulting in significant dust contamination of surfaces (see Picture 14). It was recommended that ductwork be protected from renovation-generated pollutants to prevent contamination that may require cleaning after installation (MDPH, 2000, SMACNA, 2000). Horizontal runs of ductwork open during renovations could have served as ideal roosting areas for birds. Clean up of obvious bird waste was done, however a bird feather was noted caught behind the fresh air supply louver for a classroom, indicating that all bird related contamination may not have been cleaned from ductwork (see Picture 5). BEHA staff examined the interior of several rooftop AHUs to check for evidence of bird waste/roosting. No bird contamination was found in AHUs surveyed. Bird wastes in a building raise concerns over diseases that may be caused by exposure. These conditions warrant clean up of bird waste and appropriate disinfection. Certain molds are associated with bird waste and are of concern for immune compromised individuals. Diseases of the respiratory tract may also result from exposure to bird waste. Exposure to bird wastes is thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) is another condition closely associated with exposure to bird wastes in bird raising and other occupational settings. While immune compromised individuals have an increased risk of health impacts following exposure to the materials in bird wastes, these impacts may also occur in healthy individuals exposed to these materials.

The methods to be employed in clean up of a bird waste problem depends on the amount of waste and the types of materials contaminated. The MDPH has been involved in several indoor air investigations where bird waste has accumulated within ventilation ductwork. Accumulation of bird wastes have required the clean up of such buildings by a professional cleaning contractor. In less severe cases, the cleaning of the contaminated material with a solution of sodium hypochlorite has been an effective disinfectant (CDC, 1998). Disinfection of non-porous materials can be readily accomplished with this material. Porous materials contaminated with bird waste should be examined by a professional restoration contractor to determine if the material is salvageable. Where a porous material has been colonized with mold, it is recommended that the material be discarded (ACGIH, 1989).

The protection of both the cleaner and other occupants present in the building must be considered as part of the overall remedial plan. Where cleaning solutions are to be used, the “cleaner” is required to be trained in the use of personal protective methods and equipment (to prevent either the spread of disease from the bird wastes and/or exposure to cleaning chemicals). In addition, the method used to clean up bird waste may result in the aerosolization of particulates that can spread to occupied areas via openings (doors, etc.) or by the ventilation system. Methods to prevent the spread of bird waste particulates to occupied areas or into ventilation ducts must be employed. In these instances, the result can be similar to the spread of renovation-generated dusts and odors in occupied areas. To prevent this, the cleaner should employ the methods listed in the SMACNA Guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1995).

Greenfield School officials report periodic natural gas odors in classrooms and the locker rooms since the opening of the building. Four AHUs supply the classrooms in the original building with fresh air. Each AHU contains a natural gas combustion system that is used to provide heat to the coils. The products of combustion from the natural gas are vented from each AHU through two vertical exhaust pipes that terminate approximately 6 feet above the roof. The fresh air intake is also located approximately 6 feet above the roof surface (see Picture 15). Under certain wind conditions, products of combustion from the AHU exhaust vent may be directed toward the fresh air intake hood. With sufficient air velocity drawing air into the AHU, these products of combustion may be entrained by each AHU and distributed to classrooms. It is possible that the gas jets in the AHUs were mixing the natural gas in a rich mixture, which could lead to incomplete combustion of natural gas, thereby enhancing odors entrained by the HVAC system.

The configuration of the fresh air intake for the locker rooms and the combustion air vent for the boilers may also be problematic. The AHU for the locker rooms is located in the boiler room. According to blueprints, fresh air for the locker room AHU is located in the south courtyard in a structure labeled “the doghouse” (TLCR, 1998; see Picture 16, Blueprint 1). The combustion air supply vent for the boilers is also located within the doghouse. An examination of the interior of the doghouse structure finds that the locker room AHU fresh air intake and the boiler combustion air vent are not separated, but share the same air duct. In this configuration, the AHU has the potential to draw air and related pollutants from the boiler room. In order for boilers to combust fuel a sufficient supply of oxygen is necessary. The connection of the locker room fresh air intake to the boiler combustion air supply may have the following negative effects if the draw of air by the locker room AHU is greater than the boiler:

1. The boiler could become deprived of oxygen, creating a fuel rich combustion mixture that increases incomplete combustion products, including carbon monoxide.
2. The products of combustion produced by the boilers can be drawn by the AHU and be distributed into the locker room instead of the chimney.
3. The AHU can also draw other pollutants, including sewer odor from the sump pump, and distribute them into the locker room.
4. The decrease in combustion efficiency may lead to increased fuel consumption and increased energy costs.

In this configuration, the AHU should not operate if the boiler is operating. Air distribution to the boilers and AHU are controlled by five separate louver control systems. Ideally, the combustion air supply vent should be separated by ductwork completely from the AHU fresh air intake to prevent the draw of products of combustion.

Reports of sewer gas odor were reported in several areas within the GMS. Of note is the lower roof on the northeast section of the building. A sewer vent pipe was located below an AHU that has small vents, which draw outdoor air into the cabinet (see Picture 17). Under certain wind conditions, sewer gas from this vent may be entrained by this AHU. The AHU in the north courtyard was found drawing air from the roof level above a roof drain (see Pictures 18 and 19). Under certain conditions, the AHU may draw odors from this drain or from the accumulated materials caught in the strainer.

The kitchen area has had numerous reports of sewer gas odors. GMS officials believe that the drain system in this area may not have traps installed in drain lines or that cracks may exist in the drainpipes. Numerous efforts to remediate the problem have already been undertaken by GSD staff. Please consult the Recommendations section of this report for possible methods that may be used to identify whether dry drain traps or cracked drainpipes are the source of the chronic odor complaint.

The locker rooms have floor drains that are installed at a height that is greater than the level of the floor. These drains will tend to have dry traps if water cannot reach these drains. Science classrooms are equipped with bubbler type eye wash stations. Each of these eye wash stations is equipped with a drain trap. Without periodic water poured into the drain, the traps on the eye wash station may also dry out. A trap forms an airtight seal when water is poured down the drain. A dry trap can allow for sewer gas to back up into the building. Sewer gas can be irritating to the eyes, nose and throat.

BEHA staff noted a significant amount of wood dust in the wood shop return vent, which indicates that sawdust is aerosolized from machinery and is entrained by (drawn into) the ventilation system. The wood shop contains a dedicated AHU. The interior of the AHU was examined and significant amounts of wood dust were found accumulated in its interior. The woodshop has local exhaust ventilation for wood cutting/sanding machines that are connected to a wood dust collector in the courtyard (see Picture 20). A duct is connected to the top of the wood dust collector and appears to be ducted into the wood shop fresh air intake AHU. Wood dust can be irritating to the eyes, nose, and throat. Within the AHU are heating elements. Under certain conditions, wood dust is a fire hazard.

The art room has a pottery kiln in a separate room (TLCR, 1998; see Blueprint 2). The room was originally designed as a storeroom, with an exhaust vent to remove odors from stored materials (see Blueprint 2). In the new set of renovation blueprints, the storeroom was divided in half and depicts the installation of the pottery kiln (CFCI, 2001). A hood was installed above the pottery kiln, which is now connected into the ductwork that originally serviced the storeroom. This configuration may be problematic for the following reasons:

1. The ductwork is connected to long runs of horizontal ductwork that passes through the ceiling plenum above the guidance office and eventually terminates at an exhaust fan located on a lower roof. The configuration of local exhaust ductwork to remove heated pollutants is generally vertical, like a chimney, not horizontal.
2. Air from kilns and pollutants have a temperature of several hundred degrees. Ductwork used for exhaust of heated pollutants should be insulated to prevent heat transfer into nearby building components, such as plastic coated electrical, computer or telephone wire.
3. The air from the kiln must pass through a number of curves before entering the metal duct above the ceiling. As a general rule, each 90^o bend in ducting will reduce the draw of air by 50 percent. In this case, the exhaust duct makes roughly seven 90^o turns (540^o). Assuming that the velocity of the draw of air at the exhaust motor is 100 percent, the draw of air at the base of the vent is reduced to roughly 1 percent of the draw because of the seven 90^o bends in the duct.

4. According to the original blueprints, the exhaust vent installed to service the art storeroom was designed to exhaust 200 cubic feet per minute (cfm). The new blueprints indicate that the pottery kiln exhaust vent should draw 500 cfm of exhaust air. The new plans do not indicate that the rooftop exhaust vent was upgraded to provide the indicated draw on the new blueprint.
5. The pottery kiln vent was cut into the duct that serves the art room storeroom. If the rooftop exhaust vent is deactivated and the kiln is operating, kiln-produced pollutants may migrate to the art room storeroom. Kiln exhaust vents should be separate from the general exhaust ventilation system.

For these reasons, the kiln should not be used with this ventilation system as designed.

Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999). Cleaning products were found on counter-tops and beneath sinks in some classrooms. Cleaning products and dry erase board markers and cleaners contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals.

The publishing center contained multiple photocopiers and lamination machines. There was no local exhaust ventilation noted for this room. Lamination machines give off odors. Photocopiers can produce VOCs and ozone, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). Without mechanical exhaust ventilation, pollutants produced by office equipment can build up. These machines also produce waste heat. Local exhaust ventilation should be provided for this equipment and activated while it is in use to help reduce odors, pollutants, and excess heat.

Conclusions/Recommendations

The conditions observed in the GMS are somewhat complicated. The design of some rooftop AHUs, the boiler room, wood shop and locker room ventilation systems, provide opportunities for pollutants to be entrained and distributed into occupied sections of the building. The installation of floor drains in the kitchen and locker rooms may provide a pathway for sewer odors to penetrate from the plumbing system into occupied areas. The uncontrolled introduction of outdoor pollutants into the building may account for symptoms of eye, nose and throat irritation. In order to address the conditions listed in the assessment, the recommendations to be made to improve indoor air quality in the building are divided into **short-term** and **long-term** corrective measures. The **short-term** recommendations can be implemented as soon as possible. **Long-term** recommendations are more complex and will require planning and resources to adequately address overall indoor air quality concerns. In view of the findings at the time of the visit, the following conclusions and recommendations are made:

1. Consult a ventilation engineer to maximize the operation of the building's HVAC system. Have HVAC firm fully evaluate existing ductwork system for function to ensure proper distribution of fresh outside air to occupied areas.
2. Do not use the pottery kiln until adequate (separate) ventilation is provided.
3. Do not use the wood dust collector until adequate ventilation is provided.
4. Divide the "doghouse" vent with sheet metal to separate the locker room fresh air intake vent from the boiler combustion air vent. Once divided, seal remaining vents in the ductwork that allows boiler room air to be drawn into the locker room AHU.

5. Extend the height of sewer vent pipes on the roof a minimum of 2 feet above fresh air intakes for AHUs.
6. The discovery of a bird feather in a fresh air diffuser may indicate the presence of pockets of bird waste in the ductwork. This may require additional cleaning of ductwork. Implement the corrective actions recommended concerning remediation of bird wastes (MDPH, 2000).
7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
8. Pour water into locker room drains on a regular basis to keep traps wet.
9. In order to ascertain whether the pipe is cracked, BEHA staff suggested that oil of spearmint be poured into the rooftop vent pipe that services the restrooms. This should be done after school hours. If spearmint odor is detected in the kitchen, that may indicate a dry trap or broken pipe. If odor is detected from drain, pour water into pipe to fill trap, which should eliminate the spearmint odor. If odor continues, then a crack may exist in the pipe.
10. Seal holes in wall penetrations for support of awning roof to eliminate water penetration.
11. Install a gutters/downspouts to prevent excessive water exposure to gymnasium exterior brick.

12. Repair loose or missing rivets in the copper roof above the gymnasium.

13. Add an extension to the drainpipe on the atrium to deliver rainwater to ground level to prevent splashing onto the window system.

14. Render the horizontal seams in the rubber membrane roof watertight to prevent water penetration.

15. Seal the hole, noted in Picture 8, to prevent rainwater penetration along ductwork.

16. Seal the condensation drains for AHUs during the heating season to prevent entrainment of odors from roof drains. It is imperative that once the AHUs are switched to air conditioning mode that stoppers in the condensation drains be ***removed***. ***Failure to remove stoppers can result in water backup into the AHU cabinet, which can produce microbial growth.***

Long Term Recommendations

1. The exhaust system for the wood dust collector should be reconfigured to prevent the introduction of wood dust into the wood shop. Venting the wood dust collector vent into the courtyard may result in wood dust entrainment through the "doghouse" vents or the AHU on the roof above the wood dust collector. If not feasible, consideration should be given to moving the wood shop to an exterior wall or discontinue the use of the wood dust collector.

2. Consult with the Greenfield Fire Department concerning the adequacy of ductwork currently used as the exhaust vent for the kiln. The exhaust vent system for the kiln should be reconfigured to prevent the introduction of kiln pollutants into the general exhaust system. Venting the pottery kiln into the courtyard may also result in the

entrainment of kiln pollutants through the “doghouse” vents or the AHU on the roof above the wood dust collector. If not feasible, consideration should be given to moving the art room to an exterior wall or discontinue the use of the kiln.

3. Install a gutter system along the edge of the peaked roof over the auditorium to prevent excessive water exposure to AHUs and ducts on lower roofs.
4. Examine the feasibility of installing local exhaust ventilation for publishing center.
5. Examine the feasibility of installing a backsplash on the back of the awning roofs to prevent excessive water exposure to exterior brickwork.

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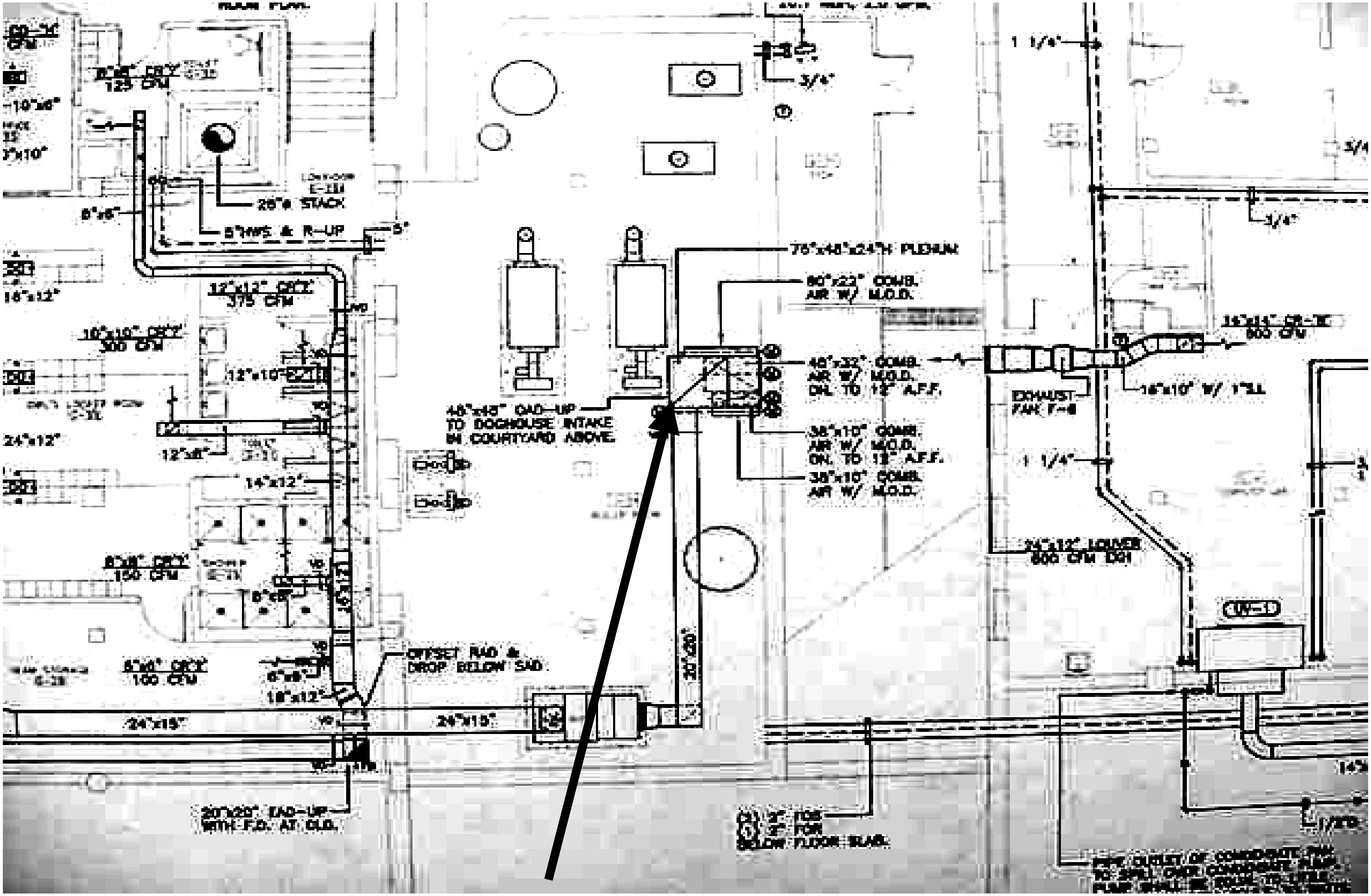
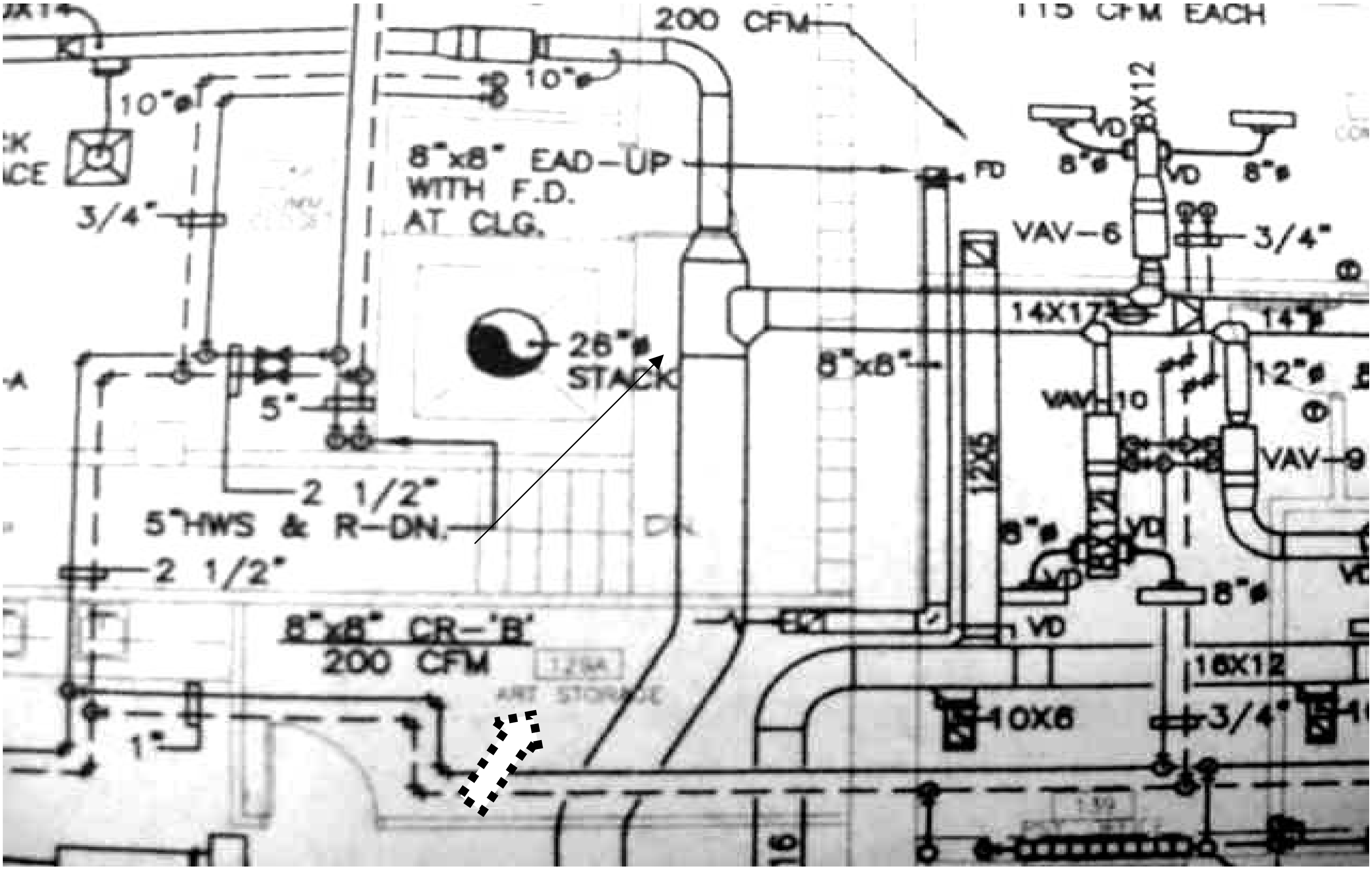
Blueprint 1

Configuration of Boiler Room Ventilation Ducts Connected to "Doghouse"



Blue Print 2

Original Configuration of Kiln Room, Note Label "ART STORAGE" (see arrow)



Picture 1

AHU for Original Building

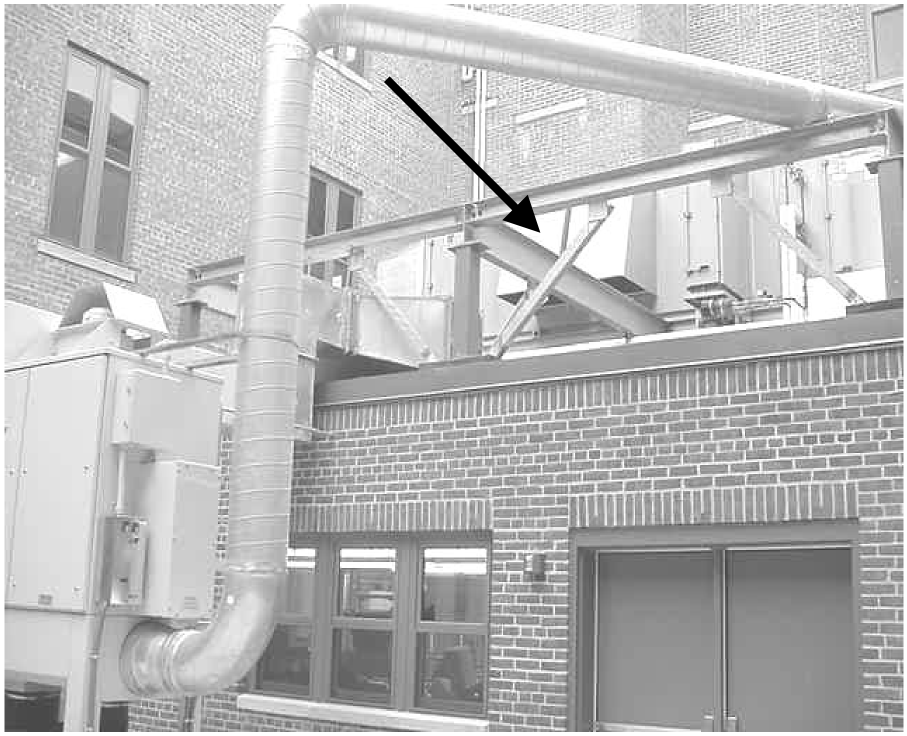
Picture 2

AHU in North Courtyard, Lower Roof

Picture 3

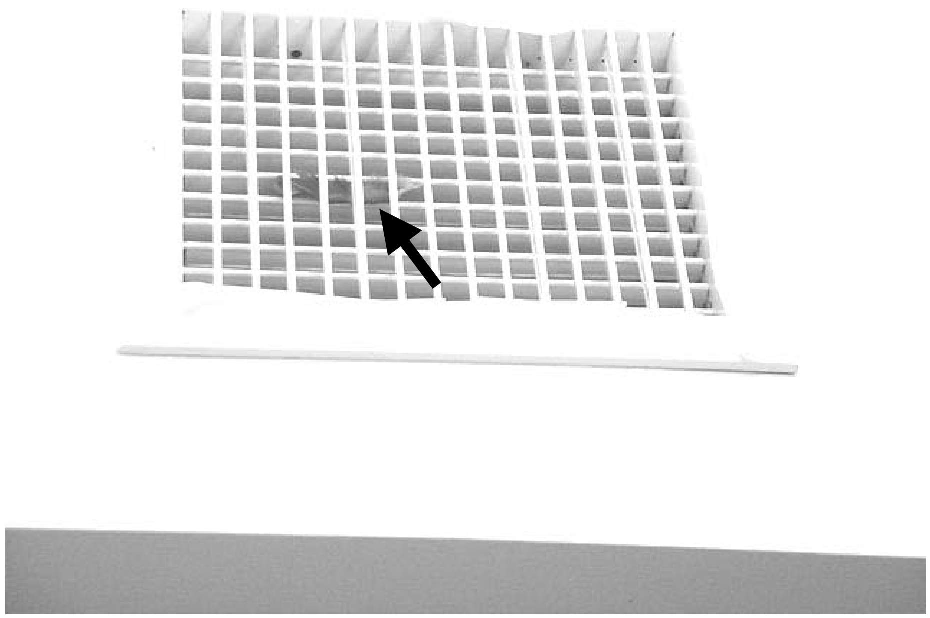
AHU on Rear Lower Roof

Picture 4



AHU in the South Courtyard, Lower Roof, Above Wood Dust Collector

Picture 5



Typical Wall Mounted Fresh Air Diffuser, Note Feather in Louvers

Picture 6

Unsealed Vertical Edge of Roofing Material Adhered to Exterior Wall of Original Building

Picture 7

Unsealed Vertical Edge of Roofing Material Adhered to Exterior Wall of Original Building
Note Spray Painted Instructions

Picture 8

A Space between the Exterior Wall and Ventilation System Duct

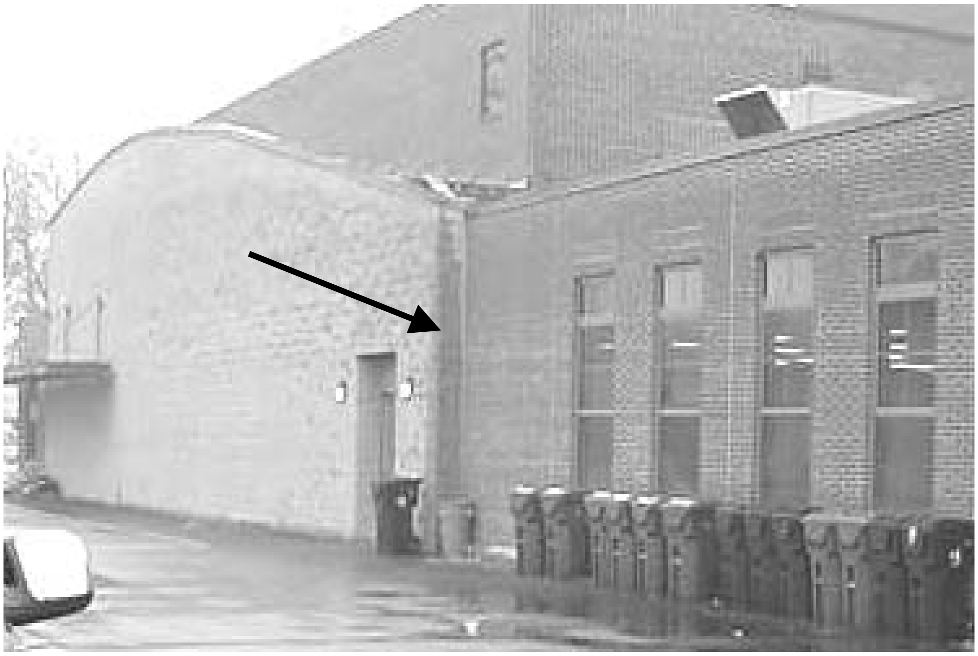
Picture 9

Riveted Section of Copper Roof

Picture 10

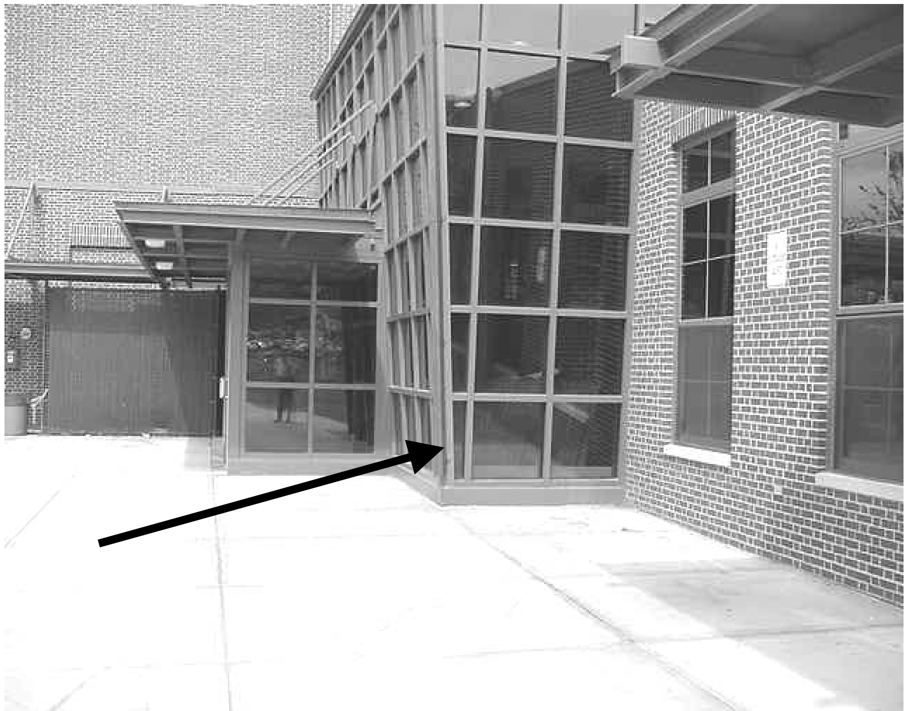
Copper Roof Section with Missing Rivets

Picture 11



Brick Discoloration on Corner of Gymnasium, Indicating Excessive Rainwater Exposure

Picture 12

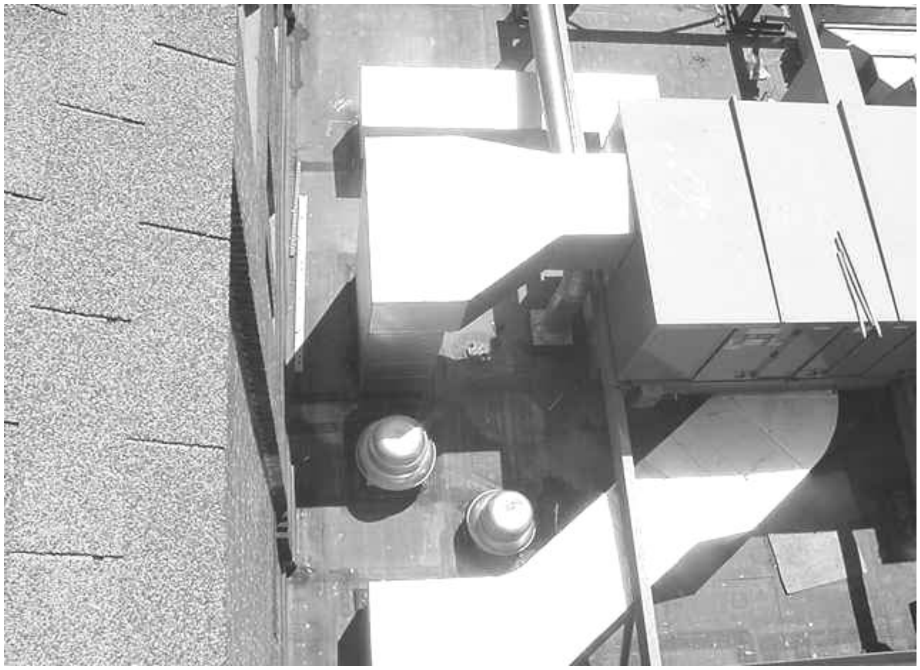


Atrium Downspout That Terminates Several Feet above the Sidewalk

Picture 13

Dust Contaminated Ductwork, in GMS during Renovations
(Line Drawn in Dust by BEHA Inspector)

Picture 14

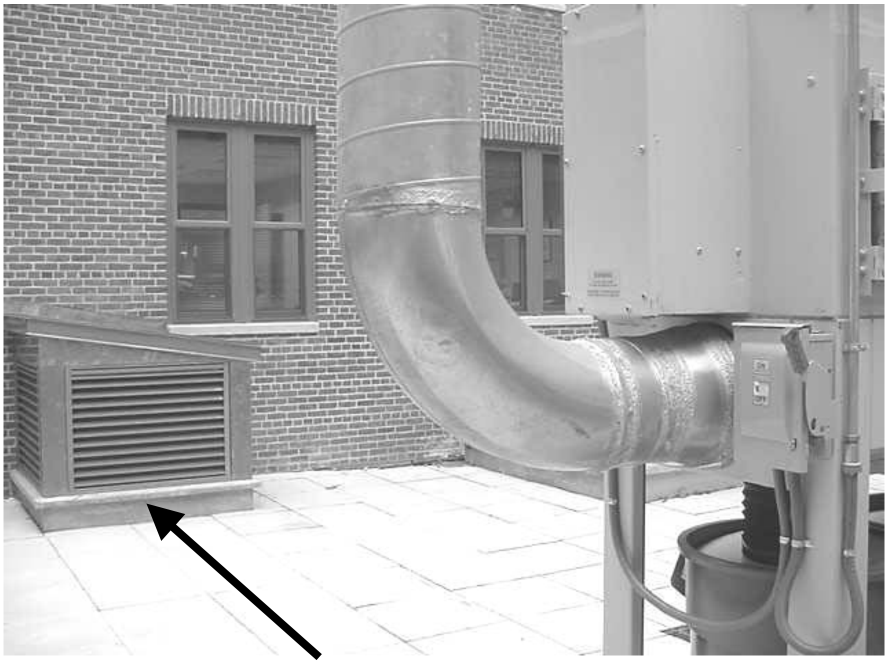


HVAC Equipment and Ductwork below the Auditorium Roof Edge

Picture 15

Exhaust Vent Pipe for Original Building AHU

Picture 16



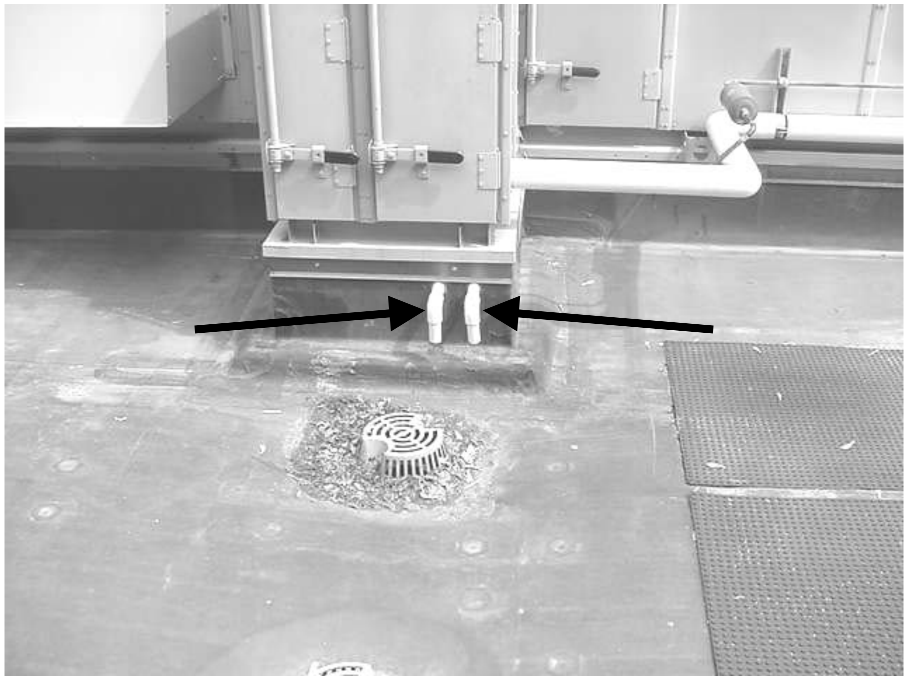
The “Dog House” Fresh Air Intake Vent

Picture 17

Sewer Vent Pipes

AHU Vents Drawing Sewer Odor from Vent Pipe(s)

Picture 18

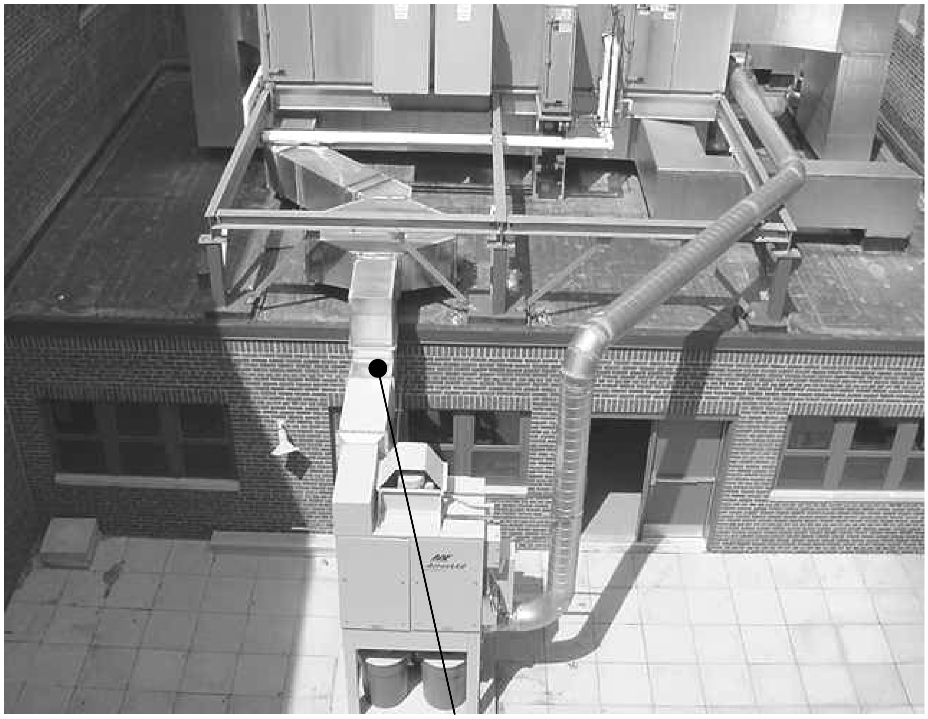


Condensation Drains for North Courtyard AHU

Picture 19

Draw of Air into Drain Sufficient to Hold Paper to Pipe

Picture 20



Wood Dust Collector

Wood Dust Collector in Courtyard, Note Duct on top of Wood Dust Collector

TABLE 1

Indoor Air Test Results – Greenfield Middle School, Greenfield, MA – January 24, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	418	42	55					@ 12 noon
Room 202	1135	72	34	24	Yes	Yes	Yes	Supply and exhaust off, window and door open, dry erase board
Room 203	1371	74	37	21	Yes	Yes	Yes	Supply and exhaust off, dry erase board, door open
Room 204	892	73	33	4	Yes	Yes	Yes	Supply and exhaust off, items obstructing supply, dry erase board, plants
Room 207	1159	73	35	19	Yes	Yes	Yes	Supply off, dry erase board
Room 208	1022	73	34	17	Yes	Yes	Yes	Supply and exhaust off, window open, dry erase board
236 – Nurse	586	71	32	1	Yes	Yes	Yes	Supply and exhaust off
Room 239	686	73	33	4	Yes	Yes	Yes	Supply and exhaust off, laser jet printer-odor
Room 216	956	72	33	6	Yes	Yes	Yes	Supply and exhaust off, dry erase board
Room 215	1330	72	34	25	Yes	Yes	Yes	Dry erase board

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Greenfield Middle School, Greenfield, MA – January 24, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 214	1123	73	35	24	Yes	Yes	Yes	Supply and exhaust off
Room 212	1730	73	38	20	Yes	Yes	Yes	Supply and exhaust off, dry erase board, eye-wash
Room 211	1800	72	39	19	Yes	Yes	Yes	Supply and exhaust off, dry erase board, plants
Room 310	858	69	37	20	Yes	Yes	Yes	Wall mounted supply/exhaust vents, dry erase board
Room 311	956	70	35	17	Yes	Yes	Yes	Dry erase board, door open
Room 312	690	70	35	17	Yes	Yes	Yes	Eye-wash station, musty odor
Room 313/314	981	70	36	23	Yes	Yes	Yes	
Room 315	465	72	33	0	Yes	Yes	Yes	Plants
Room 316	674	72	33	17	Yes	Yes	Yes	Supply obstructed, accumulated items, door open
Room 317/318	679	72	34	19	Yes	Yes	Yes	Door open
Room 107	1550	71	35	17	Yes	Yes	Yes	Supply and exhaust off, plants

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Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Greenfield Middle School, Greenfield, MA – January 24, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Room 101	2126	73	38	22	Yes	Yes	Yes	Supply and exhaust off, plants
Room 102	1142	75	35	12	Yes	Yes	Yes	Supply and exhaust off
Room 103	845	74	32	14	Yes	Yes	Yes	Supply off, dry erase board, plants
Room 104	1337	73	34	13	Yes	Yes	Yes	Dry erase board, door open, plant
Room 124	782	71	32	0	No	Yes	Yes	24 computers
Room 108	1779	72	38	17	Yes	Yes	Yes	Supply taped shut, dry erase board, door open, cleaning product
Room 144	2066	72	39	13	Yes	Yes	Yes	Dry erase board, cleaning product, eye-wash
Room 121	1136	72	35	3	Yes	Yes	Yes	Water damage-around light fixture
Room 127	634	76	32	18	No	Yes	Yes	14 computers, door open
Art Room	571	67	38	0	Yes	Yes	Yes	Kiln-hoses
Room 116	2392	72	42	18	Yes	Yes	Yes	Supply and exhaust off, dry erase board

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 4

Indoor Air Test Results – Greenfield Middle School, Greenfield, MA – January 24, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Room 114	783	71	36	1	Yes	Yes	Yes	Supply and exhaust off, dry erase board
Room 115	1166	71	35	14	Yes	Yes	Yes	Supply and exhaust off, dry erase board, door open, rubber odor
Room 112	1281	72	37	19	Yes	Yes	Yes	Eye-wash, door open
Room 111	1883	72	38	14	Yes	Yes	Yes	Supply and exhaust off, dry erase board
Room 110	1643	71	36	16	Yes	Yes	Yes	Supply and exhaust off, dry erase board
Student Services Office	577	72	35	3	No	Yes	Yes	
QLC 132	709	73	32	4	No	Yes	Yes	Supply off, dry erase board
Room 130	613	73	32	1	No	Yes	Yes	Supply off
Room 210	1131	71	34	22	Yes	Yes	Yes	Supply and exhaust off
Room 227	541	70	32	3	Yes	Yes	Yes	Supply and exhaust off
Library	467	73	31	1	Yes	Yes	Yes	

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results – Greenfield Middle School, Greenfield, MA – January 24, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 304	635	71	33	5	Yes	Yes	Yes	Dry erase board, door open
Room 321	693	71	34	10	Yes	Yes	Yes	Dry erase board, accumulated items
Room 329	589	70	34	15	Yes	Yes	Yes	26 computers, air conditioner
Outdoors (@ 4:00 PM)	406	44	62					

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%